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Formulation and Evaluation of Poly Herbal Dentifrices

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ABSTRACT

Oral diseases such as dental caries, gingivitis, and periodontal infections are among the most prevalent health problems worldwide. The increasing use of synthetic oral care products containing chemical additives has raised concerns regarding their long-term safety and potential disruption of beneficial oral microflora. The present study aimed to formulate and evaluate a polyherbal dentifrice using medicinal plants known for antimicrobial, anti-inflammatory, antioxidant, and astringent properties. Selected herbal ingredients including Azadirachta indica, Syzygium aromaticum, Glycyrrhiza glabra, Acacia nilotica, Curcuma longa, Ocimum sanctum, and others were incorporated into different formulations of herbal tooth powder. The prepared formulations were evaluated for organoleptic characteristics, physicochemical parameters, flow properties, phytochemical constituents, antimicrobial activity, and safety profile. The pH of the formulations ranged between 6.08 and 6.50, indicating compatibility with oral tissues. Moisture content (0.46%) and ash value (0.90%) confirmed the stability and purity of the formulation. Antimicrobial studies against Streptococcus mutans demonstrated zones of inhibition ranging from 12–18 mm, indicating effective antibacterial activity. Among the formulations, F2 exhibited the highest antimicrobial activity. Safety evaluation through patch testing revealed no signs of

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Introduction

Human physiology involves complex interactions among different systems that maintain homeostasis and support overall health. The oral cavity plays a crucial role in digestion, speech, and defense against microbial invasion, and therefore maintaining oral hygiene is essential for overall well-being [1–4]. The mouth contains teeth, salivary glands, oral mucosa, and tongue, which collectively contribute to mastication, taste perception, and protection against microbial infection [5–7].

Oral diseases such as dental caries, periodontal disease, gingivitis, and halitosis are mainly caused by microbial colonization and plaque accumulation in the oral cavity. Several bacterial species such as Streptococcus mutans, Porphyromonas gingivalis, and Prevotella intermedia are known to play significant roles in the pathogenesis of dental caries and periodontal diseases [8–10].

The imbalance of oral microbiota can also lead to systemic complications including cardiovascular disorders, diabetes, and respiratory infections [11–13]. Modern oral hygiene products commonly contain synthetic ingredients such as sodium lauryl sulphate, triclosan, and artificial flavoring agents. Although these compounds help control microbial growth, excessive use may cause adverse effects such as mucosal irritation, disruption of oral microbiota, and hypersensitivity reactions [14–16]. Consequently, there has been increasing interest in the development of herbal alternatives that are safer, eco-friendly, and effective in maintaining oral health. Herbal dentifrices utilize medicinal plants rich in bioactive phytoconstituents such as flavonoids, tannins, alkaloids, and essential oils, which exhibit antimicrobial, anti-inflammatory, antioxidant, and analgesic properties [17–19].

Several medicinal plants including neem (Azadirachta indica), clove (Syzygium aromaticum), liquorice (Glycyrrhiza glabra), babool (Acacia nilotica), turmeric (Curcuma longa), and tulasi (Ocimum sanctum) have been traditionally used in oral care preparations due to their ability to inhibit oral pathogens and promote gum health [20–22]. For example, neem exhibits strong antibacterial activity against Streptococcus mutans, while clove contains eugenol which possesses antiseptic and analgesic properties.

Polyherbal formulations combine multiple medicinal plants to achieve synergistic therapeutic effects and improve overall efficacy. Such formulations provide multi-targeted action by controlling microbial growth, reducing inflammation, and strengthening gingival tissues [23–25]. Herbal dentifrices are therefore gaining popularity as natural alternatives to conventional toothpaste products. Considering the increasing

demand for natural oral care products, the present study was undertaken to formulate and evaluate a polyherbal tooth powder using selected medicinal plants to assess its physicochemical characteristics, phytochemical composition, antimicrobial activity, and safety parameters.

Materials and Methods

Selection of Herbal Ingredients

Medicinal plants such as neem (Azadirachta indica), clove (Syzygium aromaticum), liquorice (Glycyrrhiza glabra), babool (Acacia nilotica), turmeric (Curcuma longa), tulasi (Ocimum sanctum), cinnamon (Cinnamomum verum), guava (Psidium guajava), and miswak (Salvadora persica) were selected based on their reported antimicrobial and anti-inflammatory activities relevant to oral health.

Authentication of Raw Materials

All crude drugs were authenticated by a qualified botanist from the Department of Botany, S.V. University, Tirupati.

Preparation of Herbal Powder

The collected plant materials were shade dried to preserve active phytoconstituents. The dried materials were powdered using a mechanical grinder and passed through sieve number 80 to obtain uniform particle size.

Formulation of Polyherbal Dentifrice

Different formulations (F1–F5) were prepared by blending herbal powders with excipients such as calcium carbonate, sodium bicarbonate, and rock salt. The ingredients were mixed by geometric dilution to ensure uniform distribution and stored in airtight containers.

Organoleptic Evaluation: The formulations were evaluated for color, odor, taste, texture, and appearance.

Physicochemical Evaluation

The following parameters were determined:

- pH determination
- Moisture content (Loss on drying method)
- Ash value
- Bulk density and tapped density
- Angle of repose

Phytochemical Screening:

Qualitative phytochemical tests were performed to detect alkaloids, flavonoids, saponins, steroids, and carbohydrates using standard procedures.

Antimicrobial Evaluation

Antimicrobial activity was assessed using the agar well diffusion method against Streptococcus mutans.

Safety Evaluation: Patch testing was performed to evaluate skin irritation or allergic reactions.

Results and Discussion

Table 1: Organoleptic Properties

Parameter	F1	F2	F3	F4	F5
Color	Olive green	Light brown	Brownish green	Dark green	Green
Odor	Characteristic herbal	Mild clove	Mild mint	Strong herbal	Pleasant mint
Taste	Astringent	Slightly salty	Mild bitter	Astringent	Pleasant herbal
Texture	Fine	Fine	Fine	Fine	Fine
Appearance	Powder	Powder	Powder	Powder	Powder

Table 2: pH Values of Formulations

Formulation	pH
F1	6.08
F2	6.45
F3	6.32
F4	6.50
F5	6.40

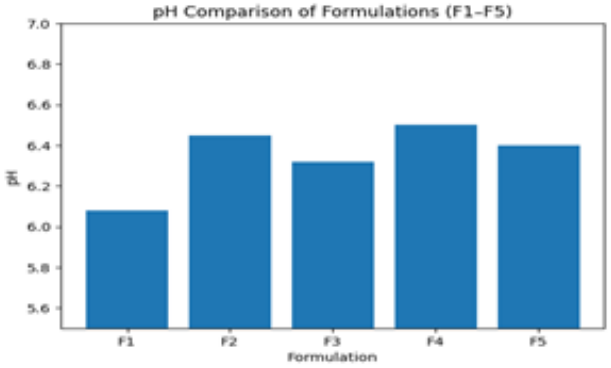

Fig.1: pH comparision of Formulations

Table 3: Angle of Repose

Formulation	Angle of Repose (°)
F1	25.16
F2	27.40
F3	26.85
F4	28.10
F5	26.30

Table 4: Bulk Density

Formulation	Bulk Density (g/ml)
F1	0.44
F2	0.48
F3	0.46
F4	0.50
F5	0.47

Table 5: Zone of Inhibition

Formulation	Zone of Inhibition (mm)
F1	12
F2	18
F3	16
F4	17
F5	15

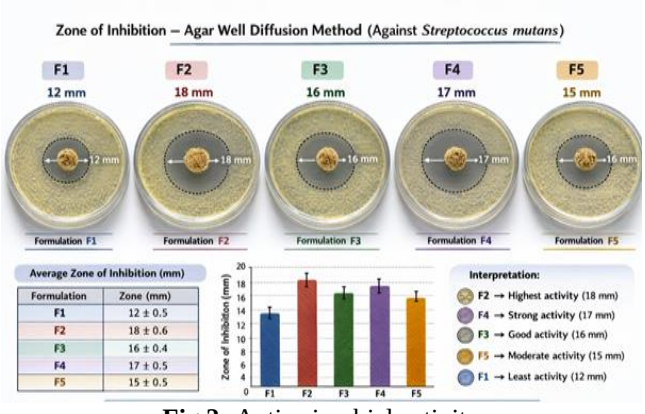

Fig.2: Anti-microbial activity

Table 6: Moisture Content

Parameter	Value
Moisture Content	0.46%

Table7: Ash Value

Parameter	Value
Total Ash	0.90%

Organoleptic Properties:
All formulations exhibited acceptable organoleptic characteristics including fine powder texture and pleasant herbal odour.

Physicochemical Parameters
The pH of the formulations ranged between 6.08 and 6.50, which is suitable for maintaining oral pH balance and preventing enamel demineralization. Moisture content was found to be 0.46%, indicating good stability and low risk of microbial contamination. The ash value was 0.90%, confirming the purity of herbal ingredients.

Flow Properties:
The angle of repose for all formulations was below **30°**, indicating good flow properties suitable for packaging and storage.

Antimicrobial Activity
The zone of inhibition against Streptococcus mutans ranged from **12–18 mm**.

- F2 showed the highest activity (18 mm)
- F4 showed strong activity (17 mm)
- Other formulations showed moderate activity

The enhanced antimicrobial activity of F2 may be attributed to higher concentrations of neem and clove, which contain bioactive compounds such as azadirachtin and eugenol.

Safety Evaluation
Patch testing indicated that the formulations were non-irritant and safe for topical oral application. Overall, the results confirm that polyherbal dentifrices possess good physicochemical stability, antimicrobial activity, and safety profile.

Conclusion
The present study successfully formulated and evaluated polyherbal dentifrices using medicinal plants known for their antimicrobial and anti-inflammatory properties. The prepared formulations exhibited satisfactory organoleptic characteristics, near-neutral pH, low moisture content, and good flow properties. Phytochemical analysis confirmed the presence of bioactive compounds responsible for therapeutic activity. Antimicrobial studies demonstrated significant inhibitory activity against Streptococcus mutans, indicating the potential of the formulation in preventing dental caries and plaque formation. Among the tested formulations, F2 exhibited superior antibacterial activity while F5 showed better organoleptic acceptability. The results indicate that polyherbal dentifrices can serve as safe, economical, and effective alternatives to synthetic oral care products. Further studies involving clinical trials and long-term stability testing are recommended to validate their therapeutic potential and commercial applicability.

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Conflict of Interests
The authors declare no conflict of interest

Ethics Approval: Not applicable

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AI Tool Declaration
The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

Data Availability
Data will be available on request

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